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Mass- and light-horizons, black holes' radii, the Schwartzschild metric and the Kerr metric

Improved calculus.

(using gravitomagnetism)

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Abstract

Black holes generally are defined as stellar objects which do not release any light. The Schwarzschild radius, derived from GRT, defines the horizon radius for non-rotating black holes. The Kerr metric is supposed to define the "event horizon" of rotating black holes, and this metric is derived from generally "acceptable" principles. The limit for the Kerr metric's horizon for non-rotating black holes is the Schwarzschild radius.
By analysing the horizon outcome for rotating and non-rotating black holes, using the Maxwell Analogy for Gravitation (MAG)[5,6,7,8] (or historically more correctly: the Heaviside[2] Analogy for Gravitation, often called gravitomagnetism), I find that the Kerr metric must be incomplete in relation to the definition of "event" horizons of rotating black holes. If the Maxwell Analogy for Gravitation (gravitomagnetism) is supposed to be "a good approach" of GRT, we may assume that it is a valid analysis tool for the star horizon metrics.
The Kerr metric only defines the horizons for light, but not the "mass-horizons". I find both the "light-horizons" and the the "mass-horizons" based on MAG. Moreover, I deduct the equatorial radii of rotating black holes. The probable origin of the minutes-lasting gamma bursts near black holes is unveiled as well. Finally, I deduct the spin velocity of black holes with a 'Critical Compression Radius'.
The deductions are based on the findings of my papers *"Did Einstein cheat?"*, *"On the geometry of rotary stars and black holes"* and *"On the orbital velocities nearby rotary stars and black holes"*.

Keywords. Maxwell Analogy – gravitation – rotary star – black hole – Kerr Metric – torus – gyrotation – horizon
methods : analytical
Graphs. WZ-Grapher

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1. The orbital velocities nearby Rotary Stars and Black Holes.

Introduction: the meaning of mass-horizons.

The horizon can -unhappily- be defined as the ultimate possible orbit of masses about the spinning star. In order to find the horizon's radius in this chapter, I look after the orbit which has an orbital velocity of the speed of light. This horizon I call the "mass-orbit horizon" or simply the "mass-horizon". If the horizon's radius is greater than the star radius, we can speak of a black hole of the mass-horizon-type, or at least of a "equator black hole" (or "partial black-hole") of the mass-horizon-type. Indeed, the region of the poles of spinning stars do not respond to the same requirements than the equator, and thus is not emission-free.

Let us look at the bending of objects about stars into orbits. Firstly, we have the Newtonian gravitation force. Secondly, we have the attracting force due to the spin of the star. Therefore, we first need to find the second gravitation field ("magnetic" part of gravitomagnetism, what I call "gyrotation").
From my paper *"A coherent double vector field theory for Gravitation"*, we have the basic equation of the gyrotation part $\boldsymbol{\Omega}$ ("magnetic" part) of gravitomagnetism for spheres :

$$\vec{\Omega}_{\mathbf{ext}} \Leftarrow -\frac{\boldsymbol{G\,m\,R^2}}{\boldsymbol{5\,r^3c^2}}\left(\vec{\omega}-\frac{\boldsymbol{3}\vec{\boldsymbol{r}}(\vec{\omega}\cdot\vec{\boldsymbol{r}})}{\boldsymbol{r^2}}\right) \qquad (1.1)$$

or, in general:

$$\vec{\Omega}_{\mathbf{ext}} \Leftarrow -\frac{\boldsymbol{G\,I}}{\boldsymbol{2\,r^3c^2}}\left(\vec{\omega}-\frac{\boldsymbol{3}\vec{\boldsymbol{r}}(\vec{\omega}\cdot\vec{\boldsymbol{r}})}{\boldsymbol{r^2}}\right) \qquad (1.2)$$

wherein we have replaced the inertial moment of the sphere $\boldsymbol{I} = \frac{2}{5}\boldsymbol{m\,R^2}$ by a general inertia momentum I.

This equation follows from the integration of equation (1.5) below, for constant gravity, over the whole sphere. The set of Maxwell equations for Gravitomagnetism is given by the equations (1.3) to (1.10) below.

$\boldsymbol{F} \Leftarrow m'\,(\,\boldsymbol{g} + \boldsymbol{v}\times\boldsymbol{\Omega})$ (1.3) $\qquad \nabla\,.\,\boldsymbol{g} \Leftarrow \rho\,/\,\zeta$ (1.4) $\qquad c^2\,\nabla\times\boldsymbol{\Omega} \Leftarrow \boldsymbol{j}\,/\,\zeta + \partial\,\boldsymbol{g}\,/\partial\,t$ (1.5)

where $\boldsymbol{j}$ is the mass flow through a fictitious surface. The term $\partial\,\boldsymbol{g}/\partial\,t$ is added for same the reasons such as Maxwell did: the compliance of formula (2.3) with the equation :

$\text{div}\,\boldsymbol{j} \Leftarrow -\,\partial\rho\,/\,\partial\,t$ (1.6) $\qquad$ It is also expected that: $\text{div}\,\boldsymbol{\Omega} \equiv \nabla.\,\boldsymbol{\Omega} = 0$ (1.7)

and $\quad \nabla\times\boldsymbol{g} \Leftarrow -\,\partial\,\boldsymbol{\Omega}\,/\,\partial\,t$ (1.8)

It is possible to speak of gyrogravitation waves with transmission speed c.

$c^2 = 1\,/\,(\,\zeta\,\tau)$ (1.9) $\qquad$ wherein $\qquad \tau = 4\pi\,G/c^2$ (1.10).

Equations (1.3) till (1.10) below form a coherent range of equations, similar to the Maxwell equations. The electric charge is then substituted by mass, the magnetic field by *gyrotation*, and the respective constants are also substituted (the gravitation acceleration is written as $\boldsymbol{g}$, the so-called *gyrotation field* as $\boldsymbol{\Omega}$, and the universal gravitation constant out of $G^{-1} = 4\pi\,\zeta$, where G is the "universal" gravitation constant. We use sign $\Leftarrow$ instead of = because the right-hand side of the equations causes the left-hand side. This sign $\Leftarrow$ will be used when we want insist on the induction property in the equation. F is the resulting force, v the speed of mass m' with density ρ .

Combined with (1.3) $F = m'\,(g + v\times\Omega)$, this becomes for the equator plane ($\alpha = 0$) :

$$F = \frac{G\,m\,m'}{r^2} + \frac{G\,m'\,I\,\omega\,v}{2\,c^2\,r^3} = \frac{G\,m\,m'}{r^2} + \frac{G\,m'\,I\,\omega}{2\,c\,r^3} \qquad (1.11)$$

wherein v is in this case the velocity of the light, $v = c$. The sign for F has been omitted because we consider quantities here, no vectors.

Instead of forces, I prefer to use accelerations by putting $a = F/m'$. Hence : $$a = \frac{G\,m}{r^2} + \frac{G\,I\,\omega}{2\,c\,r^3} \qquad (1.12)$$

This acceleration forms a circular orbit if $a = v^2/r$, wherein v is the orbital velocity of the object : $v_{orbit} = v$.

$$\frac{v^2}{r} = \frac{G\,m}{r^2} + \frac{G\,I\,\omega}{2\,c\,r^3} \qquad (1.13)$$

By putting $v_{orbit} = c$, we can find the orbit radius where the orbit velocity should reach the speed of light. This deduction is purely theoretical, because very probably this case will lead to a disintegration of the orbiting matter into gamma rays. For any orbit closer to the black hole, no matter orbits will still subsist.

By filling $v_{orbit} = c$ in (1.12), we get:

$$c^2 = \frac{G\,m}{r} + \frac{G\,I\,\omega}{2\,c\,r^2} \qquad (1.14)$$

The positive solution of (1.14)

This equation is quadratic in r if we multiply it by r^2. And of the two solutions, we only keep the positive one:

$$r_{MH} = \frac{G\,m}{2\,c^2} \pm \sqrt{\left(\frac{G\,m}{2\,c^2}\right)^2 + \frac{G\,I\,\omega}{2\,c^3}} \qquad (1.15)$$

Thus, the faster the star spins, the larger the matter-horizon-radius $r = r_{MH}$ becomes. It is probable that (1.15) gives the condition of disintegration of matter near a spinning star, due to the high energies involved for masses reaching the speed of light, and it seems reasonable to take in account this possibility.

And for non-rotating black holes, the orbit radius (matter horizon) becomes:

$$r_{MH} = \frac{G\,m}{c^2} = \frac{R_s}{2} \qquad \text{if} \qquad \omega = 0 \qquad (1.16)$$

which is half the Schwarzschild radius R_s : $$R_s = \frac{2\,G\,m}{c^2} \qquad (1.17)$$

Equation (1.16) means that if an object is orbiting at (almost) the speed of light about a star without a spin, that star must not be larger than half the diameter of a Schwarzschild black hole.

In the following lines, I simplify (1.15) for fast spinning stars with masses of at least that of the sun. Equation (1.15) becomes after some manipulation:

$$r_{MH} = \frac{G\,m}{2\,c^2}\left(1 + \sqrt{1 + \frac{2\,I\,c\,\omega}{G\,m^2}}\right) \qquad (1.18) = \textit{(1.15)}$$

The second term under the root sign is smaller than 1. Thus, knowing that:

$$x << 1 \quad \Rightarrow \quad \sqrt{1+x} \approx 1 + \frac{1}{2}x \tag{1.19}$$

it follows that:

$$r_{MH} \approx \frac{G\,m}{c^2}\left(1 + \frac{I\,c\,\omega}{2\,G\,m^2}\right) \qquad \text{for} \qquad \frac{I\,c\,\omega}{2\,G\,m^2} << 1$$

(1.20.a) ≈ *(1.15)*
(1.20.b)

The expression (1.20.b) is valid for all the known celestial objects.

Since the definition of the Schwarzschild radius is :

$$R_s = \frac{2\,G\,m}{c^2} \tag{1.17}$$

the equation (1.20.a) can be re-written as:

$$\boxed{r_{MH} \approx \frac{R_s}{2} + \frac{I\,\omega}{2\,m\,c}}$$

(1.21) ≈ *(1.15)*

The equation (1.21) shows that the evolution of the mass-horizon radius is nearly linear in ω. The faster the star spins, the wider away from its center the mass-horizon orbit becomes. This equation means that no mass can 'survive' for that radius, nor smaller radii. Moreover, when mass orbits as close as the matter-horizon-radius $r = r_{MH}$, the orbit speed must reach c and matter must disintegrate.

The negative solution of (1.14)

Remark that the negative solution of the quadratic equation (1.14) does not have yet a clear physical meaning here. It would be quite speculative to associate this equation with the empty inner space of a torus black hole, but this option merits a closer study.

$$r = \frac{G\,m}{2c^2} - \sqrt{\left(\frac{G\,m}{2c^2}\right)^2 + \frac{G\,I\,\omega}{2\,c^3}} \tag{1.22}$$

In my former paper *"On the shape of black holes"* I demonstrated, using MAG, the high probability of torus black holes when they spin fast. These two mass-horizons could signify the confirmation of my earlier finding.
Here, the equations describe the (quite unusual) conditions of an orbital velocity of matter at the speed of light. In the discussion chapter, these issues will be further explained.

In the following lines, I simplify (1.22) for fast spinning stars with masses of at least that of the sun. Equation (1.22) becomes after some manipulation:

$$r = \frac{G\,m}{2c^2}\left(1 - \sqrt{1 + \frac{2\,I\,c\,\omega}{G\,m^2}}\right)$$

(1.23) = *(1.22)*

The second term under the root sign is expected to be far smaller than 1. Hence, knowing that:

$$x << 1 \quad \Rightarrow \quad \sqrt{1+x} \approx 1 + \frac{1}{2}x \tag{1.19}$$

it follows that for fast spinning stars, the second mass-horizon becomes:

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$$r_{MH-} \approx -\frac{I\,\omega}{2\,m\,c} \qquad (1.24)$$

It might be very possible that equation (1.24) has no physical meaning. Remark that it is mass-independent.

The torus shape of fast spinning stars

In the paper *"On the shape of rotary stars and black holes"* I deduct that fast spinning stars are torus-shaped. Can this also be deducted from the MAG mass-horizon?

Indeed, in the same paper, I come to the conclusion that when particles arrive in the torus' hole, the only stable motion is a circular equatorial orbit which is retrograde to the torus' spin. When looking at (1.24) , there is a surprising minus sign. And this is perfectly complying with a retrograde orbit. When (1.21) and (1.24) are graphically represented (fig.1.1) , it becomes clear that the two mass-horizons (red boundaries) differ only with the width of half the Schwarzschild radius.

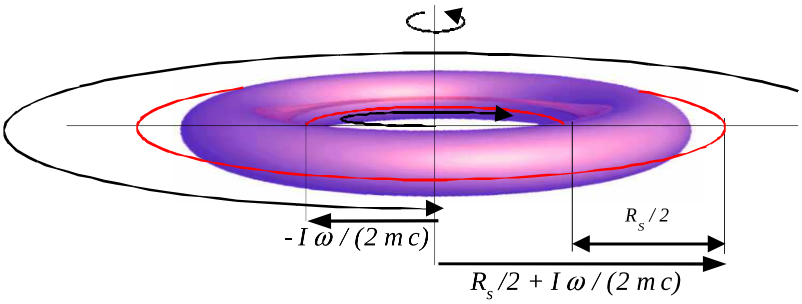

Fig.1.1. *The spinning star mass-horizons (red lines)*

Thus, according to an earlier paper [8] , the shape of the mass-horizon of fast spinning stars is torus-like, and it can be expected that such spinning stars are torus-like as well with a thickness much below $R_s/2$.

This chapter gives the solution for the zone nearby the black hole where matter tends to orbit at the speed of light.
Before discussing the findings of this chapter more in depth, I first study the general problem of the bending of light nearby black holes.

2. The bending of light into a circular orbit.

Introduction: the meaning of a light-horizon and the Kerr Metric.

Another approach could be the study of the bending of light by the spinning star. Schwarzschild found one "event" horizon for non-rotation black holes by applying GRT. With the Kerr metric, which gives the conditions nearby black holes, two horizons are found. Here, I look for horizons via the Maxwell Analogy.

Although this chapter seems to be quite identical to the former one, there is an important difference. Here, I speak of the bending of *light* in the gyrogravitation field, and not about *matter* in an orbit. And the result of circular light-bending is called the *light-horizon*.

For this purpose, we take the solution which we have found in *“Did Einstein cheat?”* [7], equation (6.14), written in its general form.

$$-F_{\varphi,\alpha} = G\frac{2\,m\,m'}{r^2} + G\frac{m\,m'}{2\,r^2 c^2}v_1^2\cos^2\alpha + G\frac{m\,m'\,R^2\,\omega_\varphi^2}{5\,c^2\,r^2}\cos^2\varphi \qquad (2.1)$$

This equation describes the bending of light, taking in account three forces and thus three terms, based on : *1°* the pseudo-gravitational effect for light, which is two times the value of the Newton gravitation; *2°* the gyrotation force due to the orbit velocity of the star in its galaxy (in the present case: of the Milky Way, where α is the angle between the orbiting object at velocity v_1 and the axis between the center of the Milky way and the sun) and *3°* the star rotation (in the present case: the sun) while the light passes at a certain latitude φ . And I found this equation to be far more accurate than the GRT derivation.
The finding in this derivation was that light is not bent by gravitational effects (because the rest mass of light is zero), but only by the gyrotation field of the mass beam of the light wave itself, traveling in the gravitation field of the star.

The equation (2.1) has been written for light that is grazing the sun (or any massive object). This must be changed into an equation that is valid for any distance of the light to the center of the celestial object and for any type of inertial moment, not only for spherical objects. Below, this will be adapted by starting from the following concepts : the first term of (2.1) remains valid, the second term will not be considered further and the third term will be adapted as said before.

What specifies the light-horizon of black holes?

In this case, of course, I do not consider the Milky Way's dragging velocity v_1 , which I assume to be insignificant nearby the black holes we want to study.

Besides staying at the equator level of the star only, I consider accelerations instead of forces. So, the perpendicular acceleration upon the light becomes, in analogy with equation (1.12), wherein only the Newtonian term gets a double value :

$$a = \frac{2G\,m}{r^2} + \frac{G\,I\,\omega}{2\,c\,r^3} \qquad (2.2)$$

Since this acceleration is a bending, thus, radial acceleration, and since we look at the light performing a circular orbit, the acceleration a is supposed to also comply with the centripetal acceleration v^2/r, which is a purely geometrical formula. For light, we replace the speed v by c.

Hence:

$$\frac{c^2}{r} = \frac{2G\,m}{r^2} + \frac{G\,I\,\omega}{2\,c\,r^3} \qquad (2.3)$$

By making this equation quadratic in the radius r of the light-horizon $r = r_{MH}$, we get the following solutions:

$$r_{LH} = \frac{G\,m}{c^2} \pm \sqrt{\left(\frac{G\,m}{c^2}\right)^2 + \frac{G\,I\,\omega}{2\,c^3}} \quad \text{or} \quad r_{LH} = \frac{G\,m}{c^2}\left(1 \pm \sqrt{1 + \frac{I\,c\,\omega}{2\,G\,m^2}}\right) \qquad (2.4.a) = (2.4.b)$$

The second term under the root sign is expected to be far smaller than 1. Hence, knowing that:

$$x \ll 1 \quad \Rightarrow \quad \sqrt{1+x} \approx 1 + \frac{1}{2}x \qquad \textit{(1.19)}$$

we can write this as a positive and a negative solution :

$$r_{LH+} = \frac{2G\,m}{c^2}\left(1 + \frac{I\,c\,\omega}{8\,G\,m^2}\right) \quad \text{and} \quad r_{LH-} = -\frac{I\,\omega}{4\,m\,c} \quad \text{if} \quad \frac{I\,c\,\omega}{2G\,m^2} \ll 1$$

(2.5) ≈ *(2.4)*⁺
(2.6) ≈ *(2.4)*⁻
(2.7)

Remark that r_{LH-} is independent from the mass. Hence, it is very possible that (2.6) has no physical meaning, but it might have the meaning of a retrograde orbit inside the hole of the torus.

Equation (2.5) also can be written as :

$$\boxed{r_{LH+} \approx R_s + \frac{I\,\omega}{4\,m\,c}} \qquad (2.8) \approx (2.4)^+$$

wherein R_s is the Schwarzschild radius.

Equation (2.8) is thus describing the bending of light beams in a circular orbit about black holes.

Horizons cannot be defined better than with this equation. In the discussion chapter, it will become clear why this is so.

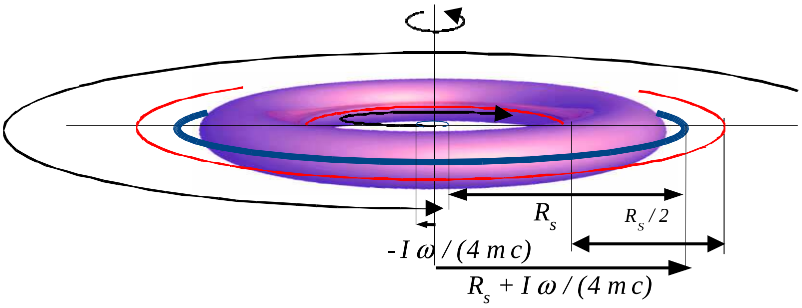

Fig.2.1. The spinning star mass-horizons (red lines) and its light-horizon (dark line).

As shown in fig.2.1, the external light-horizon's diameter is always smaller than the external mass-horizon diameter.

3. Deriving the radius of Pure Black Holes.

Evolution of the Pure Black Hole's radii.

If, as I found, (2.8) describes the horizon of black holes, there is a special case which even goes beyond that result: when the light-horizon coincides with the star equator, a part of the star is invisible, even when looking from the poles to the star, whereas this obscuration was not the case in the former horizons. I speak of “Pure Black Holes” at the limit where the equator of the star is obscured. Light cannot escape, and the light horizon is the star equator. Hence, I can describe partial black holes, whereof a part is invisible, even observed from the poles.

To manage this, we need to adapt the parameters of equation (2.8) as follows :

For thin rings and thin toruses in general, $I = \lambda\, m\, R^2$, where R is the radius at the equatorial level of the star, and the factor $\lambda \le 1$.
By putting $r_{LH} = R$, I obtain a circular bending of light upon the equator of the star itself.
Since we look for the case where $r\,\omega \approx c$, equation (2.10) can then be replaced by:

$$R_{\text{pure}} = \frac{R_s}{(1-\lambda/4)} \qquad (3.1)$$

wherein R_s is again the Schwarzschild radius.

We see immediately that, for a ring black hole, when the light horizon reaches the ring's radius itself, this ring's radius must have reached about 4/3th of the Schwarzschild radius (the Schwarzschild radius stands for the theoretical spherical non-rotating black hole).
Note that the value for the spin rate of that Pure Black Hole equals to $\omega \approx c / r$, as defined earlier.

Remark that the concept of Pure Black Hole is only theoretical. If the spin velocity becomes close to the speed of light, disintegration of the matter particles is extremely probable.

The graphic evolutes as expected: the higher the spin, the smaller the radius of the light circle becomes. Equation (3.1) is beautifully describing the required radius at the equator level of rotating Pure Black Holes.

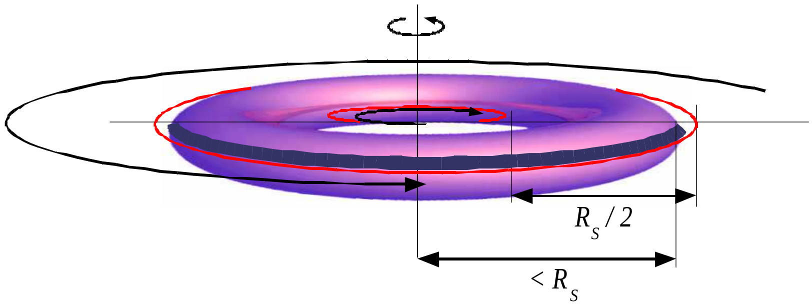

Fig.3.1 *The Pure Black Hole's light-horizon and mass-horizons*

It is then clear that if I depict this graphically, I get fig.3.1. , wherein I show the light-horizon (large dark boundary) and the mass-horizons (red boundaries) as well.

Spin velocity of Black Holes at the Critical Compression Radius.

In a former paper[8], I have deducted the radius of continuous mass compression at the equator level of spherical stars (with negligible Newtonian-gravitation influence). This deduction was based on the gyrotation field equations for a sphere, and we use (1.2) in order to obtain a more general equation. The minus sign signifies “attraction”.

$$\vec{\Omega}_{\text{ext}} \Leftarrow -\frac{G\, I}{2\, r^3 c^2}\left(\vec{\omega} - \frac{3\vec{r}(\vec{\omega}\cdot\vec{r})}{r^2}\right) \qquad (1.2)$$

Herein r is the distance to the center of the sphere, R is the radius of the sphere and ω is the spin velocity.

The equatorial compressive gyrotation force is given by the analogue Lorenz force $a_x = \omega\, R\, \Omega_y$ (3.2)

and the last term of (1.2) is zero in the direction of the spin axis, so $\Omega_y = 0$.

Hence, the acceleration due to gyrotation at the equator plane is:

$$a_x = -\omega^2 R \frac{G\, I}{2\, r^3 c^2} \qquad (3.3)$$

At the other hand, we have the following forces: the centrifugal force and the gravitation force. For fast spinning stars, the gravitation force can be neglected, and we find that, in general:

$$a_{\text{tot}} = \frac{G\, m}{r^2} + \omega^2 R\left(1 - \frac{G\, I}{2\, r^3 c^2}\right) \qquad (3.4)$$

which becomes zero at an equilibrium at the Compression Radius $r = R = R_C$.

The angular velocity at which this occurs is given by :

$$\omega_C = \frac{2}{R}\sqrt{\frac{G\,\lambda\,m}{R_s - 4R}} \qquad (3.5)$$

wherein I have put $I = \lambda\, m\, R^2$ as a simplification. The dimensionless parameter λ generally has a value between 0 and 1. Remark that R must comply with $4R < R_S$.
When that angular velocity has been reached, and the black hole became explosion-free, we call the black hole "Perfect".

Since in this case, the value of the angular velocity is high, the Newtonian gravitation is much smaller than the gyrotational one. By neglecting the Newtonian gravitation, we find that a_{tot} is zero, for thin ring-shaped pure black holes, if:

$$R_C = \lambda\, R_s / 4 \qquad (3.6)$$

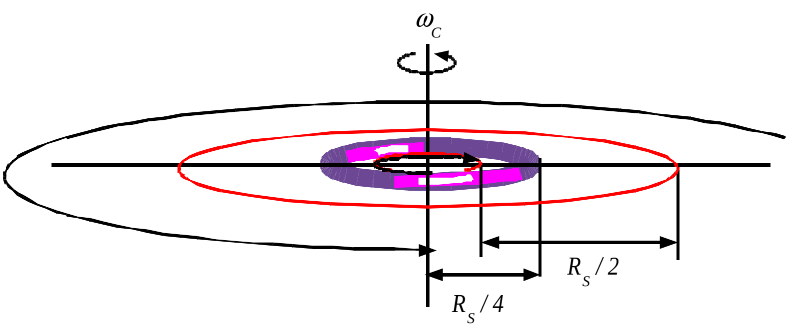

Fig.3.2. *The Perfect MAG Black Hole with spin velocity ω_C , when the Critical Compression has been reached.*

The non-explosion condition (3.5), valid for all ring-shaped stars, defines the exterior radius of the ring-shaped spinning star for a total continuous compression at the equatorial level. By comparing (3.6) with (3.1), there is no way by finding a spinning black hole that is simultaneously Pure and Perfect. Thus, black holes cannot be at the same time *pure*, and explosion-free.
Indeed, the minimum requirements for the perfect spinning black hole, which cannot explode and which can disintegrate orbiting matter, would then be given by the combination of the metrics, given by fig.3.2. Al these metrics can coexist mathematically.

4. Discussion: Three approaches, three important results.

Orbiting masses at the speed of light.

The first derivation (1.15) for finding horizons resulted in the search of the orbit of matter traveling at the speed of light about the spinning star. The meaning of this orbit is however not very clear. Could this be the horizon of the star? Not really, because this equation goes about matter instead of light.
On the other hand, is seems to be correct that no more light can overpass this boundary, as far as matter effectively disintegrate at that place.

$$r_{MH} \approx \frac{R_s}{2} + \frac{I\,\omega}{2\,m\,c} \qquad (1.21)$$

But when the matter disintegrates, and when it transform to gamma rays, these rays obey to other rules. The gamma rays will be emitted and will –in most of the cases– not be cached by the star. The disintegration of an orbiting object near such a star will indeed emit enormous gamma bursts during seconds or minutes. Such gamma bursts are observed and (1.21) is very probably the origin of these observations. Longer bursts are not likely, because partly disintegrated masses become lighter, and will look up slower orbits, laying at higher distances from the black hole.

Resuming, when one is purely speaking of the concept "event horizon", which is the circular bending of light, (1.15), or (1.21) , is not exactly the expected solution.

In the first place, the Kerr metric is in contradiction with (1.15) concerning its horizon concept, because of the doubtful compliance of horizons with orbiting masses at the speed of light. From (1.15) follows moreover that for non-rotating stars the limit radius of the mass-horizon becomes:

$$\omega = 0 \quad \Rightarrow \quad r = \frac{R_s}{2} \qquad (4.1) = (1.16)$$

Surprisingly, the Kerr metric is quasi identical to (1.15) , apart from a constant factor 2 , which allows the Kerr metric to obtain the Schwarzschild radius as a limit for ω = 0 . But this seems more to be an artifice.

The conclusion is that the Kerr metric simply has not to be considered as a matter horizon.

The bending of light and the Kerr metric.

More likely, the bending of light should be the correct approach for defining the concept of "event horizon". This happens in (2.8):

$$r_{LH+} = R_s + \frac{I\,\omega}{4\,m\,c} \qquad (2.8)$$

Herein, the Schwarzschild radius is obtained for the limit where ω = 0 . As explained before, it seems much more logical to consider the circular bending of light as the correct definition of the event horizon.

The concept of the Kerr metric is in disagreement with the solution (2.4) , or (2.8) , but in agreement with (1.15). The mathematical expression (2.4) has a very simple set-up consisting of a non-rotating term, and a term, linear in ω, when rotation occurs. Of course, the horizon exists only at the condition that its radius is larger than the star radius.

Comparing both types of horizons

Comparing graphically both equations (1.21) and (2.8) gives the picture (fig. 4.1).

The radius in the upper graphic (circular orbit at the speed of light) raises very quickly with increasing spin velocity. The lower graphic (circular bending of the light), which is barely increasing, starts at the Schwarzschild radius. So, for black holes with a relatively slow rotation velocity, the "light-horizon" is nearly constant at that same radius. The "mass-horizon" graphic however moves immediately towards higher radii.

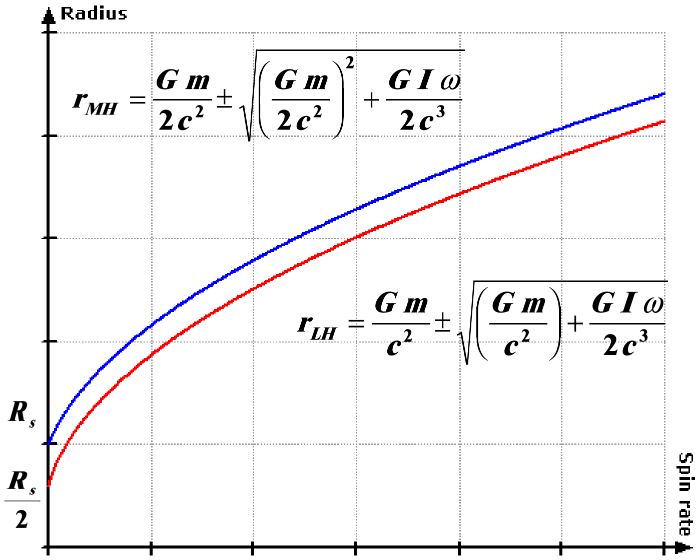

Fig. 4.1. *Comparing the radii of matter horizon (MH) and light horizon (LH).*

A precise calculus shows that for an incoming object near a spinning black hole, the matter horizon always follows after the light horizon at a fixed distance of $R_s/2$, whatever the spin rate is. This means that we never can see a disintegration of matter (except by tidal forces) , because firstly the limit of the light horizon has to be passed. However, since spinning black holes are torus-like, matter disintegration at the matter horizon can be made visible at the side of the poles of the star.

4. Conclusion.

There exist two types of horizons: the first one is based on the orbital velocities of matter, orbiting at the speed of light, (called: mass-horizon) and the second is based on the bending of light towards a circular orbit (called: light-horizon). Both are purely deducted from the Maxwell Analogy theory for Gravitation (gyrogravitation).

The mass-horizon type has two mathematical solutions, whereof the negative signed one isn't totally clear, but which might represent the inner hole of a torus black hole. This would totally comply with our former paper. In an earlier paper[8], I found indeed that fast spinning stars can partially explode, and that they normally end up in torus-shaped black holes. This first type of horizon (mass-horizon) allows me to find a very plausible origin of gamma bursts which last for several seconds or minutes: the disintegration of mass at the speed of light (which became invisible to the eye) into gamma rays, which suddenly become then visible, because the light cannot be bent as much in order to remain captured.

The Kerr metric is almost identical to the MAG light-horizon, in order to get the Schwarzschild radius as a limit for non-rotating black holes.
The MAG light-horizon defines the “event horizon” of black holes in its pure form, as the ultimate circular boundary of visible light about the black hole.

Both horizon types can coexist, but at some very low and very high spin velocities, the light-horizon obscures the mass-horizon, so that even gamma bursts might totally be captured by the spinning black hole, which might hold these bursts invisible, unless they can escape via the poles of the ring (torus) black hole, as I explained in an earlier paper[8].
Beyond these deductions, the radii of spinning and non-spinning black holes are found, as a special case of the light-horizon.
Finally, the spin velocity of black holes with continuous compression has been found.

5. References.

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